(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 589 663 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number : **93307438.7**

(51) Int. Cl.[5] : **A61F 5/04,** A61F 5/40

(22) Date of filing : **20.09.93**

(30) Priority : **21.09.92 US 948123**

(43) Date of publication of application :
30.03.94 Bulletin 94/13

(84) Designated Contracting States :
AT BE CH DE DK ES FR GB GR IE IT LI LU MC NL PT SE

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(54) Humeral fracture brace.

(57) There is described a humeral fracture brace, comprising :
(a) a humeral cuff for providing rigid lateral support to the humerus ;
(b) a forearm support ; and
(c) sliding hinge means for pivotally connecting the humeral cuff to the forearm support and allowing the forearm support to slide relative to the axis of the humeral cuff.

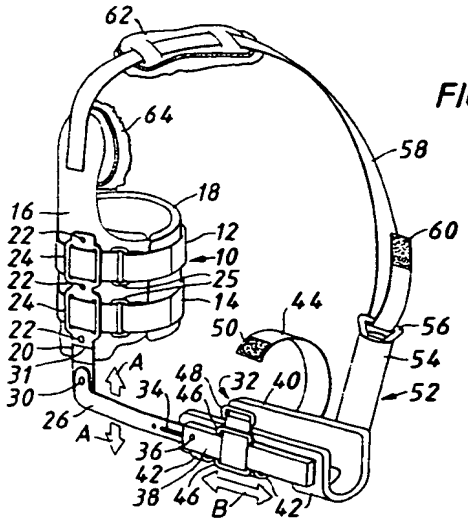

FIG. 2.

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The present invention relates to orthotic devices, and more particularly, to a fracture brace for the post trauma treatment of fractures of the humeral shaft.

Numerous braces are known which are useful for maintaining broken bone segments of the upper arm or humerus in a fixed position during healing. The most common type of brace is a plaster cast which has the disadvantage of being heavy, uncomfortable and cumbersome. Various braces of semi-rigid material have been used for external fixation of upper arm fractures. Braces of this type are shown and described in US patents 4,436,088 and 4,576,153, where a bracing member supports the humerus without stabilising the remaining portions of the patient's arm.

US patent 1,466,487 is directed to a more supportive humeral brace that is clamped to the shoulder and pivotally connected to a forearm support. However, the brace provides no support to the patient's wrist, nor does it allow for anything but pivotal movement between the humeral and forearm support.

The invention is directed to a brace for supporting a fractured humerus, which has both a humeral support and a forearm support. The humeral support is formed of a circumferential cuff which has a pair of tensioning straps for allowing differential compressive connections to the humerus.

According to the invention we provide a humeral fracture brace, comprising:

(a) a humeral cuff for providing rigid lateral support to the humerus;

(b) a forearm support; and

(c) sliding hinge means for pivotally connecting the humeral cuff to the forearm support and allowing the forearm support to slide relative to the axis of the humeral cuff.

The humeral support may have a plastic shell and rigid humeral brace bar for holding the fractured portions of the humerus in place relative to each other, the rigid humeral brace bar being connected to a forearm brace bar through a sliding hinge and resilient or elastic member which urges the humeral brace bar toward the humerus. Appropriate pads may also be provided between the plastic shell and humerus. The hinge allows for relative pivotal movement between the forearm brace bar and the humeral brace bar and at the same time permits the forearm brace bar to move along the axis of the humeral brace bar so that traction/distraction of the fracture can be accomplished through weights added to the forearm of the patient.

A pair of tensionable straps may be provided for connecting the humeral cuff to a patient's upper arm. The forearm support may include a rigid bar for connection to the humeral cuff and a generally U-shaped cuff for engaging to a patient's wrist. A sliding connection may be included between the rigid humeral brace bar and generally U-shaped cuff for adjusting the length of the forearm support.

The forearm brace bar includes a longitudinal bar and a cuff that supports the wrist and hand of the patient for controlling the forearm angle relative to the humeral brace bar and to allow immobilisation of the forearm. The wrist/hand cuff can be slidably connected to the forearm brace bar to accommodate different forearm lengths. The forearm brace bar can be disconnected from the humeral cuff for greater patient mobility during latter stages of recovery.

A strap, which may be adjustable, may be connected between the upper end of the humeral cuff and the wrist/hand cuff for immobilising the forearm at an appropriate angle relative to the humerus. A pad is slidably mounted on or connected to the strap for bearing against the neck and shoulder of the patient to better distribute weight from the strap. A pad is also mounted on the inner surface of the upper portion of the humeral cuff, which bears against the patient's deltoid muscle in order to distribute weight at that location. Weight is thus distributed in three places, at the wrist/hand cuff, the pad mounted on the strap and the deltoid pad.

The sliding hinge means of the brace may be provided with a longitudinal slot formed in the humeral cuff and a pivot pin mounted on the forearm support for engaging the slot. The pivot pin may be urged toward the humeral cuff by a spring means. The spring means may include a resilient member connected between the pivot pin and humeral cuff. The brace may be provided with weight means adapted to fit around the forearm of a patient.

According to a further feature of the invention we provide a humeral fracture brace, comprising:

(a) a humeral cuff for providing rigid lateral support to the humerus;

(b) a forearm support;

(c) a hinge means for pivotally connecting the forearm support to the humeral cuff;

(d) a support strap for connecting the proximal end of the humeral cuff with the distal end of the forearm support;

(e) a slidable support pad on the support strap for distributing weight to the neck and shoulder of a patient;

(f) a support pad mounted on the proximal inner surface of the humeral cuff adjacent to a patient's deltoid muscle for distributing weight to a patient's shoulder.

The support strap may include means for adjusting the length of the strap and may include removable connections to the humeral cuff and forearm support. The brace may also be provided with means for disconnecting the forearm support from the humeral cuff.

In order to acquire a better understanding of the invention, reference may be had to the detailed description of exemplary embodiments, set forth below, considered in conjunction with the appended draw-

ings, in which:

Figure 1 is a schematic view of the humeral fracture brace applied to a patient;

Figure 2 is a perspective view of the fracture brace of the present invention;

Figure 3 is an exploded perspective view of the connections between components of the humeral cuff and between the humeral cuff and the forearm brace bar; and

Figure 4 shows the forearm portion of the fracture brace of Figure 2 with weights connected to the patient's forearm in-order to illustrate the traction/distraction feature.

Referring to the drawings, the brace of the present invention is shown, with Figure 1 showing in particular how it is worn by a patient. The brace has a humeral cuff 10 which is connected to the humerus of the patient through a pair of tensioning straps 12, 14 so that the compression on the humerus can be controlled.

The humeral cuff 10 is formed of a plastic shell 16 which engages the humerus through a padded liner 18 formed of an open cell foam material. A rigid brace bar 20 is connected to the outer surface of the shell 16 through rivets or screws 22. The plastic shell is rigid enough to provide support to hold broken bone fragments in the humerus together, but flexible enough to open sufficiently for placement around the humerus as shown in Figure 1.

The brace bar 20 includes a pair of slotted connection guides 24 through which the tensioning straps 12, 14 are threaded. The straps 12, 14 are formed of a woven fibrous material, with a D-ring 25 connected at one end so the other end can loop through the D-ring 25 and connect to itself through a known hoop and loop connection such as sold under the Trade Mark **VELCRO** R.

The brace bar 20 is connected to a forearm brace bar 26 through a sliding hinge which is formed of a slot 28 located at the distal end of humeral brace bar 20 (see Figure 3), and a pivot pin in the form a rivet 30, which is mounted on the proximal end of the brace bar 26. The sliding hinge allows the forearm brace bar to move longitudinally relative to the axis of the humeral cuff 10 as shown by the arrows A in Figure 2, which is advantageous for reasons discussed below when weights are mounted on the patient's forearm as shown in Figure 4.

Figure 3 is an exploded perspective view that shows the preferred structure of the humeral cuff 10 and its connection to the brace bar 26. The slotted connection guides 24 are connected to the plastic shell 16 through rivets 22 which are upset after they are passed through washers 23. A spring or elastic element 27 is connected between the rivet 22 closest to the sliding hinge and the rivet 30 for urging the brace bar 26 upwardly toward the humeral cuff 10. The elastic element 27 is formed of any suitable elastomeric material such as a urethane plastic that is strong to urge the brace bar 26 upwardly in the slot 28, but resilient enough to allow the brace bar 26 to move downwardly when weights are attached as shown in Figure 4. Suitable washers 29 are provided between adjacent components. Sections of the hooked gender of hook and loop material 21 such as **VELCRO**R are spaced around the outer surface of the plastic shell to provide a better connection with the straps 12, 14 and the strap 58, described below.

The brace bar 20 is scribed or scored as shown by line 31 so that the portion of the brace bar 20 between the scribe line 31 and the brace bar 26 can easily be broken away from the remaining portion of the humeral cuff 10. This feature allows the brace bar 26 to be disconnected and removed during the final stages of rehabilitation.

A U-shaped cuff 32 for supporting the wrist and hand of the patient is mounted on the distal end of the forearm brace bar 26 through a sliding connection formed of a slot 34 in the forearm brace bar 26 and a pin 36 mounted on a support 38. The cuff 32 is in effect an extension of the forearm brace bar 26 and engages the wrist/hand of the patient through appropriate padding 40 formed of an open cell foam held in place by three U-shaped supports 42.

The sliding connection between the slot 34 and the pin 36 allows the wrist/hand cuff 32 to move back and forth in the direction of arrow B to accommodate different forearm lengths and provide for greater comfort. A strap 44, formed of woven fibrous material, extends around the wrist/hand cuff 32 and is threaded through a pair of loops 46 mounted on the extension 38, the strap 44 having a D-loop 48 at one end so that a **VELCRO** R patch 50 of a hooked gender can be passed through the loop 48 and connected to the strap 44.

A hand grip 52 is formed by providing a padded gripping portion 54 over an extension 56 of the outermost U-shaped support 42. The extension 56 is in the form of a loop so that a support strap 58 can be connected between the upper portion of the plastic shell 16 of the humeral cuff 10 and the loop portion 56. The shoulder strap can be adjusted for immobilising the forearm of the patient at a preselected angle through a **VELCRO** R patch 60 which folds back over a remaining portion of the strap 58. The other end of the strap 58 is connected to the plastic shell 16 through a hook and loop connection formed between the hooked section 21 shown in Figure 3 and the woven fibrous material of the strap 58 so that the strap can be removed when it is no longer needed by the patient.

A shoulder/neck pad 62 is slidably connected to the strap 58 for distributing loads to the shoulder and neck of the patient. A deltoid pad 64 is mounted on the inner surface of the plastic shell 16 for distributing loads to the shoulder of the patient at the location of

the deltoid muscle, as best shown in Figure 1.

When the humeral brace as described is used on a patient, the humeral fracture is stabilised through what is called 3-point stabilisation. This means that while the fractured bone sections are immobilised, optimum control and comfort at the fracture site are provided through primary contact at the wrist/hand cuff 32, the neck/shoulder pad 62, and the deltoid pad 64. This system provides for more even distribution of weight while the patient is wearing the brace, while at the same time reducing stresses at the fracture site.

By providing the sliding hinge between the humeral brace bar 20 and the forearm brace bar 26, traction/distraction on the fracture can be accomplished without altering the position of the humeral cuff 10, through the addition of one or more weights 66 on the forearm of the patient as shown in Figure 3. These weights 66 can be generally U-shaped with a strap 68 for connecting the ends together after they are in the position shown in Figure 4. When the weights 66 are attached, the brace bar 26 will move away from the humeral cuff 10, overcoming resistance of the material which forms the elastic member 27 (see Figure 3).

The humeral brace described above has been found to be an extremely versatile alternative to casting and can be used for support and containment immediately after reduction of the fracture throughout the entire recovery period and during the final stages of rehabilitation. The rigid connection between the humeral cuff 10 and the patient's arm allows the fracture to heal properly. The vertical sliding hinge allows the fractured portions to be placed in traction/distraction during the initial stages of recovery without having to change the position of the humeral cuff 10. By separating brace bar 20 at the scribe line 31, the distal end of the brace bar 20 and brace bar 26 may be removed during the final stages of rehabilitation to provide the patient with greater mobility.

The design provides for a rigid, yet lightweight brace that is extremely comfortable to wear because of the three-point stabilisation system. The patient is allowed maximum mobility without sacrificing the need to maintain the fractured bone totally immobile during the earlier stages of recover. While the brace is worn, joint motion at the shoulder, elbow, wrist and fingers is possible without sacrificing stability at the fracture site. This allows exercises to be started at an early time during the recovery period, which significantly reduces muscle atrophy and shortens rehabilitation time.

It should be understood that the foregoing description is exemplary of the invention and not restrictive, and that improvements and modifications can be made to the invention without departing from the spirit and scope of the invention as defined in the appended claims.

Claims

1. Humeral fracture brace, comprising:
   (a) a humeral cuff for providing rigid lateral support to the humerus;
   (b) a forearm support; and
   (c) sliding hinge means for pivotally connecting the humeral cuff to the forearm support and allowing the forearm support to slide relative to the axis of the humeral cuff.

2. The brace of claim 1, wherein the humeral cuff includes a plastic shell, a padded liner for the shell and a rigid brace bar connected to the shell.

3. The brace of claim 2 and further including a pair of tensionable straps for connecting the humeral cuff to a patient's upper arm.

4. The brace of claim 1, wherein the forearm support includes a rigid bar for connection to the humeral cuff and a generally U-shaped cuff for engaging to a patient's wrist.

5. The brace of claim 4, and further including a sliding connection between the rigid bar and generally U-shaped cuff for adjusting the length of the forearm support.

6. The brace of claim 1, wherein the sliding hinge means includes a longitudinal slot formed in the humeral cuff and a pivot pin mounted on the forearm support for engaging the slot.

7. The brace of claim 6, and further including spring means for urging the pivot pin toward the humeral cuff.

8. The brace of claim 7, wherein the spring means includes a resilient member connected between the pivot pin and humeral cuff.

9. The brace of claim 1, and further including weight means adapted to fit around the forearm of a patient.

10. The brace of claim 1, and further including an adjustable shoulder strap for connection between the humeral cuff and the forearm support.

11. The brace of claim 10 wherein the shoulder strap includes a pad slidably connected to the strap for distributing weight to a patient's shoulder.

12. The brace of claim 10, and further including a deltoid pad connected to the inner surface of the humeral cuff adjacent to a patient's deltoid for distribution of weight to a patient's deltoid.

13. Humeral fracture brace, comprising:
    (a) a humeral cuff for providing rigid lateral support to the humerus;
    (b) a forearm support;
    (c) a hinge means for pivotally connecting the forearm support to the humeral cuff;
    (d) a support strap for connecting the proximal end of the humeral cuff with the distal end of the forearm support;
    (e) a slidable support pad on the support strap for distributing weight to the neck and shoulder of a patient;
    (f) a support pad mounted on the proximal inner surface of the humeral cuff adjacent to a patient's deltoid muscle for distributing weight to a patient's shoulder.

14. The brace of claim 13, wherein the support strap includes means for adjusting the length of the strap.

15. The brace of claim 13, wherein the support strap includes removable connections to the humeral cuff and forearm support.

16. The brace of claim 13 and further including means for disconnecting the forearm support from the humeral cuff.

FIG. 1.

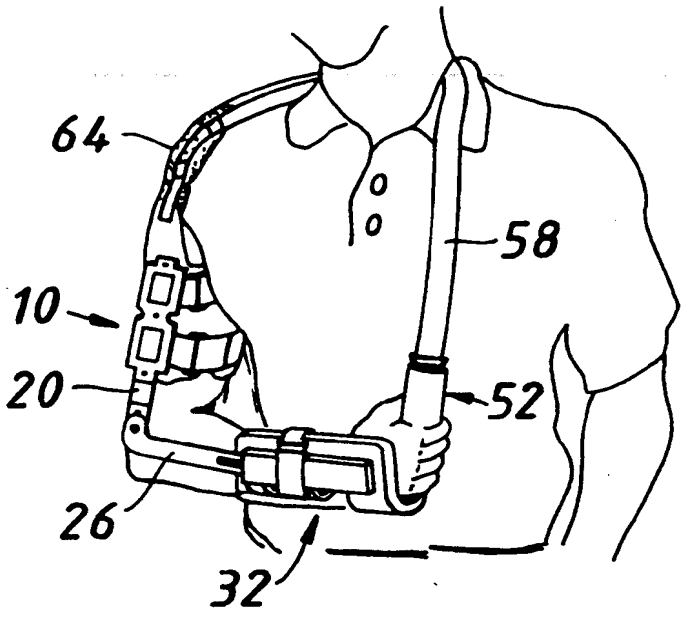
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FIG. 2.

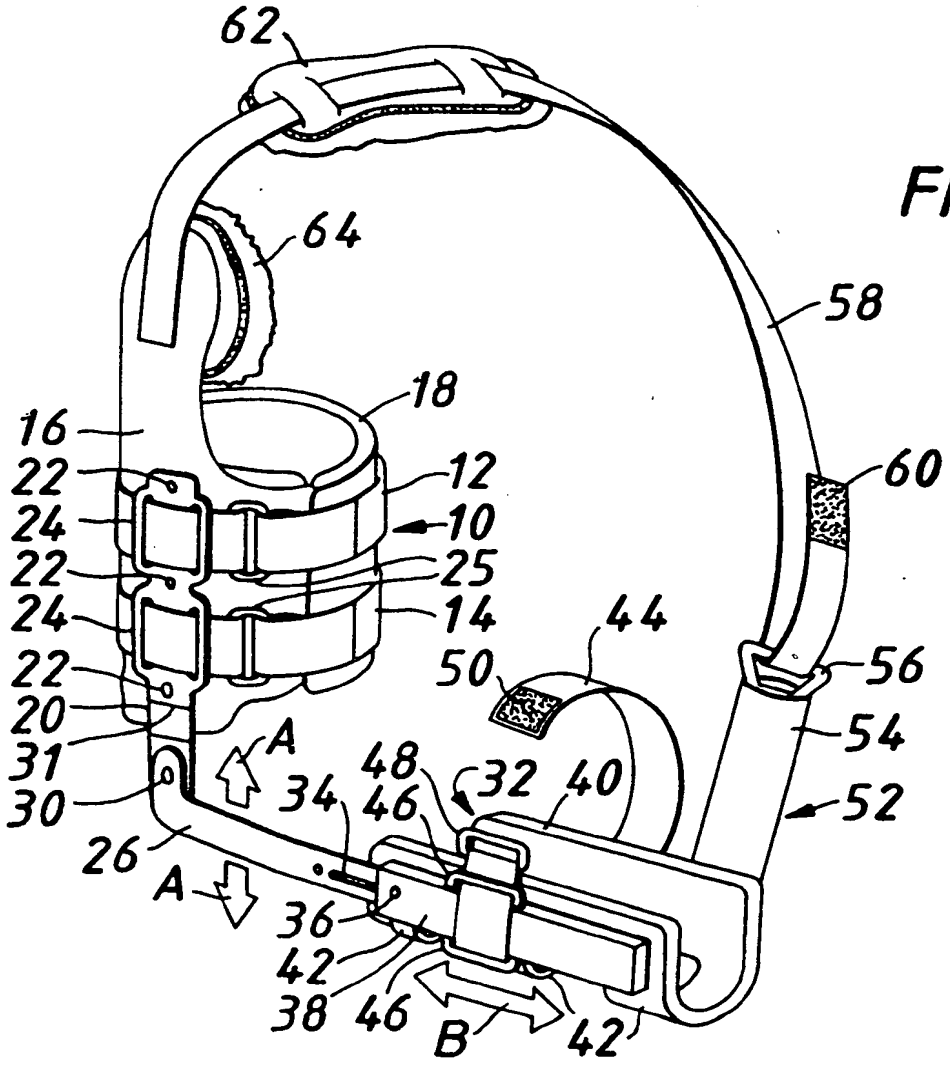
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FIG. 3.

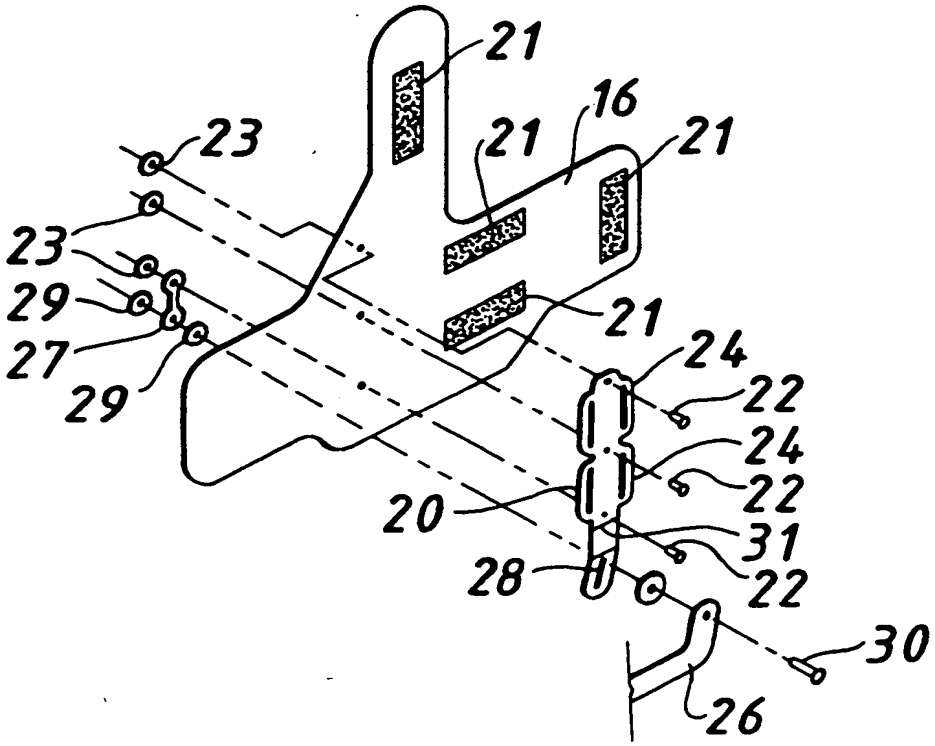
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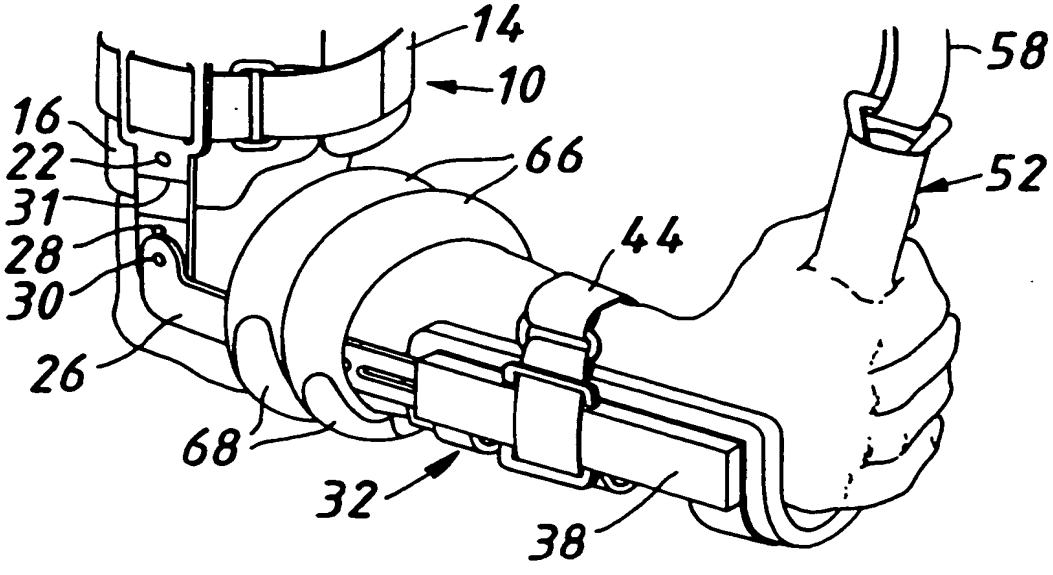
FIG. 4.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European Patent Office

EUROPEAN SEARCH REPORT

Application Number EP 93307438.7

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
D,A	US - A - 1 466 487 (R.W. SHAFFER) * Claims 1-4; figs. 1,2 *	1,4,13	A 61 F 5/04 A 61 F 5/40
A	US - A - 3 028 858 (H.W. CUTLER) * Column 2, lines 9-31; figs. 1,2,6 *	1,2,4, 13,15, 16	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

A 61 F 5/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	30-11-1993	TSILIDIS

CATEGORY OF CITED DOCUMENTS

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